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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/802,563	03/17/2004	Hong Yu Yu	NUS03-001	3494

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EXAMINER	
KIM, SU C	

ART UNIT	PAPER NUMBER
2823	

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11/01/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/802,563	YU ET AL.	
	Examiner	Art Unit	
	Su C. Kim	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 August 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *8-12,14-24,26,27,35,37-43,45-47,54-56,58 and 59* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-12,14-24,26,27,35,37-43,45-47,54-56,58 and 59* is/are rejected.

7)☒ Claim(s) *15* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *17 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

Claim 15 is objected to because of the following informalities:

In claim 15, reciting "RTA" please specify a meaning of RTA i.e. Rapid thermal annealing (RTA).

In claim 24, reciting "form a hafnium nitride first metal layer" is typographical error, perhaps a hafnium nitride as the first metal layer.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 8-9, 14, 24, 26-27, 35, 38-39, & 58 are rejected under 35 U.S.C. 102(e) as being anticipated by Haukka et al. (US 2004/0104439).

Regarding claims 8, Haukka discloses a method for fabricating a CMOS semiconductor device structure comprising gate electrodes, said method comprising:

providing a dielectric layer 110 & 119 on a substrate 101;

depositing a hafnium nitride layer 112 on said dielectric layer 110 & 119 (Fig. 1b, paragraph 0031) wherein an atomic ratio of nitrogen (paragraph 0038) and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than or equal to one (paragraph 0047, HfN is atomic ratio of 1 to 1):

depositing a capping layer 114 (Fig. 1b) on said hafnium nitride layer 112 (Fig. 1b);

patterning said hafnium nitride layer (paragraph 0014) and said capping layer and said dielectric layer to form said CMOS gate electrodes (Fig. 1b).

Regarding claim 9, as applied to claim 8, Haukka discloses that said depositing of said hafnium nitride layer comprises flowing Nitrogen and argon atoms (paragraph 0038, inactive gas) into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target.

Regarding claim 14, as applied to claim 8, Haukka discloses that impurity doping into said hafnium nitride layer 112 (Fig. 1b) to tune the work-function of said gate electrode (paragraph 0036).

Regarding claim 24, Haukka discloses a method for fabricating a CMOS semiconductor device structure comprising gate electrodes, said method comprising:

providing a dielectric layer 110 & 119 on a substrate 101;

depositing a first metal layer 112 on said dielectric 101 wherein said depositing of said first metal layer 112 (Fig. 1b) comprising flowing Nitrogen and argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium

target to form hafnium nitride first metal layer 112 (Fig. 1b) and wherein an atomic ration of Nitrogen and Hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrode wherein said atomic ratio of nitrogen to hafnium remains greater than or equal to one (paragraph 0047, HfN is atomic ratio of 1 to 1); and

depositing a second metal capping layer 114, said first metal layer 112, and said dielectric layer 110 & 119 (Fig. 1b) to form said CMOS gate electrodes; and

forming source and drain region 102 within said substrate adjacent to said CMOS gate electrode (Fig. 1b).

Regarding claim 26, as applied to claim 24, Haukka discloses that said second metal capping layer 114 comprises tungsten or tantalum nitride (paragraph 0032).

Regarding claim 27, as applied to claim 24, Haukka discloses that said first and second metal layer are deposited by PVD or CVD (paragraph 0056).

Regarding claim 35, Haukkad discloses a method for fabricating a CMOS semiconductor device structure comprising;

providing a dielectric layer 109 & 110 on a substrate 101 (Fig. 1b);

depositing a hafnium nitride layer 112 on said dielectric layer 110 & 119 wherein said depositing comprises flowing Nitrogen and Argon atom (paragraph 0038, inactive gas) into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target;

depositing a titanium nitride or tungsten capping layer on said hafnium nitride layer(paragraph 0032);

patterning said hafnium nitride layer 112 and said capping layer 114 and said dielectric layer 109 & 110 (Fig. 1b) to form CMOS gate electrodes; and

forming source and drain 102 (Fig. 1) within said substrate adjacent to said CMOS gate electrode.

Regarding claim 37, as applied to claim 35, Haukka discloses that said dielectric layer comprises HfO2 (paragraph 0015), silicon dioxide, silicon nitride, nitride silicon dioxide, zirconium oxide, aluminum oxide, tantalum pentoxide, barium strontium titanates, or crystalline oxide (paragraph 0033).

Regarding claim 38, as applied to claim 35, Haukka discloses that adjusting the nitrogen flow rate to adjunct the work-function of said gate electrodes wherein the atomic ration of nitrogen to hafnium in said hafnium nitride layer remains greater than or equal to one(paragraph 0047, HfN is atomic ratio of 1 to 1).

Regarding claim 39, as applied to claim 35, Haukka discloses that impurity doping into said hafnium nitride layer (Fig. 1b) to tune the work-function of said gate electrode (paragraph 0036).

Regarding claim 58, as applied to claim 24, Haukka discloses that impurity doping into said hafnium nitride layer 112 (Fig. 1b) to tune the work-function of said gate electrode (paragraph 0036).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and

the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 10, 12, 15, 54, 56, & 59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (US 2004/0104439) in view of Optimum range.

Regarding claim 10, as applied to claim 9, Haukka discloses that argon and nitrogen flow rates are kept (paragraph 0038).

Haukka fails to teach flow rates are kept as constant at 25 sccm and 5 sccm.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Regarding claims 12 & 56, as applied to claims 8 & 24 , Haukka discloses said dielectric layer comprising HfO2 and wherein said dielectric layer is subjected to post-deposition annealing (PDA) in N2 ambient (paragraph 0055).

Haukka fails to teach the post-deposition annealing at 700°C.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce

an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Regarding claims 15 & 59, as applied to claims 8 & 24, Haukka discloses that thermal treatment of said hafnium nitride by RTA (paragraph 0055).

Haukka fails to teach thermal treatment of said hafnium nitride at about 1000°C for about 20 second.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Regarding claim 54, as applied to claim 24, Haukka discloses that argon and nitrogen flow rates are kept (paragraph 0038).

Haukka fails to teach flow rates are kept as constant at 25 sccm and 5 sccm.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant

has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Claims 11& 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (US 2004/0104439) in view of Kubota et al. (US 2004/0087124).

Regarding claims 11 & 55, as applied to claims 8 & 24, Haukka discloses that said dielectric layer comprises HfO2 (paragraph 0043).

Haukka fails to teach HfO2 is deposited at 400 °C by using MOCVD.

However, Kuboda discloses HfO2 is deposited by using MOCVD (paragraph 0019).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Cunningham and Hayashi in combination with HfO2using a MOCVD cluster tool as taught by Kubota in order to produce thin dielectric layer.

Haukka and Kuboda in combinations fail to teach HfO2 is deposited at 400 °C

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce

an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Claims 40- 43, 45-46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li (US 6,955,986) in view of Haukka et al. (US 2004/0104439).

Regarding claim 40, Li discloses a method for fabricating a CMOS semiconductor device structure comprising:

provide a dielectric layer 208 on a substrate 203 (Fig. 2)

depositing a first metal layer 214 (Fig. 2, col. 5, lines 3-15, note : Ta, Ti, Zr, Hf, W,Mo,Co, Cr, Pd and Nb, tantalum nitride, titanium nitride, tungsten nitride, hafnium nitride)

depositing a second metal capping layer 216 on said first metal layer 214 (Fig. 2), said second metal capping layer comprising a hafnium nitride (Col. 5, line 16-20, note: one of metal used in the diffusion barrier layer i.e. HfN)

patterning said first metal 214, said second metal capping layer, 216, and said dielectric layer to form CMOS gate electrodes (Fig. 2); and

forming source and drain regions within said substrate adjacent to said CMOS gate electrodes.

Li fails to teach depositing the second metal capping comprising flowing Nitrogen and Argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form hafnium nitride layer.

However, Haukka discloses the metal layer comprising flowing Nitrogen and Argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form (paragraph 0038, inactive gas) hafnium nitride layer 112 (Fig. 1b).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Li with depositing the second metal capping comprising flowing Nitrogen and Argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form hafnium nitride layer as taught by Haukka in order to enhance device performance.

Regarding claim 41, as applied to claim 40, Li and Haukka in combination disclose that said dielectric layer comprises HfO2 (Haukka, paragraph 0043).

Regarding claim 42, as applied to claim 40, Li and Haukka in combination disclose that said first and second metal layer are deposited by PVD or CVD (Haukka, paragraph 0056).

Regarding claim 43, as applied to claim 40, Li and Haukka in combination disclose that said first metal layer comprises tungsten or tantalum nitride (Li, Col. 5, lines 4-15).

Regarding claim 45, as applied to claim 40, Li and Haukka in combination disclose that adjusting the flow rate of said Nitrogen and argon atoms (Haukka,

paragraph 0038, inactive gas) to adjust the work-function of said gate electrodes wherein the atomic ration of nitrogen to hafnium remains greater than or equal to one (Haukka, paragraph 0047, HfN is atomic ratio of 1 to 1):

Regarding claim 46, as applied to claim 40, Li and Haukka in combination disclose that impurity doping into said hafnium nitride layer (Haukka, Fig. 1b) to tune the work-function of said gate electrode (Haukka, paragraph 0036).

Claim 47 is rejected under 35 U.S.C. 103(a) as being unpatentable over Li (US 6,955,986) in view of Haukka et al. (US 2004/0104439) and further in view of Optimum range.

Regarding claim 47, as applied to claim 40, Li and Haukka in combination disclose that thermal treatment of said hafnium nitride by RTA (Haukka, paragraph 0055).

Li and Haukka in combinations fail to teach thermal treatment of said hafnium nitride at about 1000°C for about 20 second.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the

limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Su C. Kim whose telephone number is (571) 272-5972. The examiner can normally be reached on Monday - Thursday, 9:00AM to 7:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew S. Smith can be reached on (571) 272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Su C Kim
Examiner
Art Unit 2823

10/27/2007

W. DAVID COLEMAN
PRIMARY EXAMINER